eBook

WAVEFRONT by **VmWare***

How to Achieve AWS, Azure, or GCP **Observability at Scale**

A Guide to Observability and Analytics on the Enterprise Multi-Cloud using Public **Cloud Services**





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Section I: Growth & Challenges of Multi-Cloud Observability



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1. Why are Enterprises Adopting Multi-Cloud?

The adoption of multi-cloud is on the rise among enterprises. According to a <u>survey</u> conducted by analyst firm Forrester on behalf of Virtustream, **86% of respondents characterized their organizations' cloud strategy as multi-cloud.** Before going into the details of why enterprises are adopting multi-cloud, let's first clarify what's multi-cloud and how it differs from hybrid cloud.

Multi-cloud is the approach of using more than one public or private cloud providers like Amazon Web Services (AWS), Microsoft Azure (Azure) or Google Cloud Platform (GCP) to run different services. Often enterprises run a service on one or two clouds. However, because they own and run many different services – operated by different teams and businesses, they end up using multiple public and private cloud providers. No matter if you are using only one or multiple clouds, this ebook walks you through how to achieve observability for each of the major cloud providers including AWS, Azure, GCP and VMware cloud on AWS.

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Before we go into the details of each cloud, lets clarify the difference between multi-cloud and hybrid cloud. Hybrid cloud is a kind of multi-cloud which uses both private and public cloud with orchestration between the two clouds. For instance, VMware Cloud on AWS is a hybrid cloud solution that enables you to extend your on-premises Software-Defined Data Center (SDDC) to AWS public cloud with VMware vCenter acting as the orchestrator between the two. Now that we know the difference between multi-cloud and hybrid cloud, let's concentrate on multi-cloud and why enterprises are increasingly adopting a multi-cloud strategy.

Here are some of the reasons why enterprises are adopting a multi-cloud approach:

Utilize best of the breed services

AWS, Azure, and GCP provide a breath of amazing services (IaaS, PaaS, SaaS), including many CI/CD, Kubernetes, AI/ML services. Engineering teams want to benefit from those services and not re-invent the wheel.

Optimize cost

Different cloud providers have different pricing models. Organizations often make the decision to adopt different cloud providers or run dev and production workloads on a different cloud, if the price is favorable.

Mergers and Acquisitions

Large enterprises acquire different teams/ businesses that use different cloud providers as a result of mergers and acquisitions, leading to a multi-cloud environment.

Data sovereignty

Certain laws and corporate policies require enterprises to store their data in certain locations, often within country/state boundaries. Multi-cloud helps enterprises to scale to different geographies while abiding by data sovereignty laws.

Avoid vendor lock-in

Enterprises are very aware that being all-in on one public cloud provider gives that cloud provider an edge on pricing negotiations. So, enterprises often adop a multi-cloud strategy to avoid vendor lock-in.

High availability and redundancy

Maintaining high availability by hosting applications on different clouds is a common way to achieve high availability and data redundancy, especially for data backups.

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2. Challenges of Monitoring Applications Across Multi-cloud

There are many benefits of adopting a multi-cloud approach, as shown above. In fact, in many ways, the adoption of multi-cloud has made life much easier for engineering teams. They can now select the cloud of their choice, deploy in minutes, and in some cases altogether, avoid having any datacenters. Furthermore, they can take advantage of the best of breed IaaS/PaaS and SaaS services provided by different cloud providers.

But at the same time, multi-cloud has introduced many new challenges for the engineering team as well. Now instead of one cloud, engineering teams need to learn, deploy, and monitor across multiple cloud providers. Because cloud providers are so different, monitoring across different cloud environments is not easy. Here are some of the challenges faced by engineering teams while monitoring multi-cloud environments:

Siloed cloud vendor tools lead to slower troubleshooting and significant revenue impact

Organizations often start with the tools provided by the cloud vendor to monitor their applications. But they soon realize that cloud vendor tools are built for only one vendor and don't effectively monitor multi-cloud environments. To overcome this problem, Ops/DevOps teams find themselves using multiple siloed monitoring solutions that fail to provide a unified view across different cloud leading to increased troubleshooting time and significant revenue impact.

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Lack of multi-cloud support in legacy monitoring solutions

Enterprises transitioning to cloud or multi-cloud often start with using their legacy monitoring solutions (which worked for their on-premises environment). But they soon realize that legacy monitoring solutions lack multi-cloud support. Many teams spend precious resources on building monitoring capabilities across multi-cloud instead of focusing on scaling their business. Even opensource monitoring solutions have their challenges, including scale limitations, limited reliability, and lack of high availability.

Siloed cloud vendor tools lead to slower troubleshooting and significant revenue impact

Organizations often start with the tools provided by the cloud vendor to monitor their applications. But they soon realize that cloud vendor tools are built for only one vendor and don't effectively monitor multi-cloud environments. To overcome this problem, Ops/DevOps teams find themselves using multiple siloed monitoring solutions that fail to provide a unified view across different cloud leading to increased troubleshooting time and significant revenue impact.

Increased cloud cost due to underutilized resources and dynamic environments

In public cloud environments, pricing is often based on which resources you use and for how long. So, it's critical to rightsize the resources you use and not have underutilized resources. Furthermore, in public cloud environments, resource utilization can be highly dynamic. Depending on the time of day, month, or season, your cloud services environment (test vs. prod) likely requires change, and you may have a dramatic rise in resource utilization. For example, you may need more compute and storage instances during the peak shopping season, then no longer need them after peak times. Engineering teams move quickly, often forgetting

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unused cloud resources that they are getting charged for. Visibility into changes in resource capacity and performance becomes paramount to ensuring that you are not paying for unused cloud infrastructure.

Complexity of different cloud services leaves DevOps teams blind

Each public cloud provider – AWS, Azure, or GCP - is very different in terms of their architecture, capabilities, and services they offer. So, it is not trivial to learn each cloud provider and determine how to monitor applications in each cloud. The complexity of learning how to monitor applications on each of these clouds leaves DevOps teams struggling to monitor, measure, and maintain SLOs. alse RROR_Y = False y = True e_z = False = "MIRROR_Z" d.use_x = False d.use_y = False d.use_z = True

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3. Wavefront by VMware: Enterprise Observability Platform Delivering Full-Stack Observability and Analytics Across Multi-Cloud

Wavefront is an observability platform specifically designed for enterprises that need monitoring, observability, and analytics for their cloud-native applications and environments. DevOps, SRE, and developer teams use Wavefront to proactively alert on, rapidly troubleshoot, and optimize the performance of their modern applications running on the enterprise multi-cloud.

Wavefront is purpose-built for modern apps running on the enterprise multi-cloud at scale. It delivers full-stack observability with advanced analytics on metrics, traces, histograms, and span logs gathered on distributed applications, application services, container services, and a multi-cloud based on public, private, and hybrid cloud infrastructures.

Key use-cases of Wavefront include:

- Multi-Cloud Observability
- Full-Stack Observability
- Application Observability
- Kubernetes Observability
- Infrastructure Visibility
- CI/CD Visibility

"Wavefront is our enterprise-wide observability platform used by hundreds of engineers across Workday's Ops and Dev teams. With its unique analytics built on top of a common repository of full-stack operational data, Wavefront enables better team collaboration and data-driven system improvements."

- Kevin Cantoni VP Engineering

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To learn more about Wavefront and how it provides full-stack observability and analytics across enterprise multi-cloud, check out <u>wavefront.com</u>.

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4. How to Achieve Observability for AWS, Azure, or GCP

Which AWS Metrics Should You Monitor?

AWS is the leading public cloud provider. It provides a vast array of metrics that can be analyzed in Wavefront across many of its key components. Using the <u>Wavefront AWS</u> <u>Integration</u>, you get insight into ~40 AWS services and their most commonly used metrics including:

- AWS performance and utilization metrics for major cloud services such as Amazon EC2, Amazon EBS, Amazon ECS, Amazon ELB, AWS Lambda, Amazon Redshift, Amazon DynamoDB, Amazon SQS and more
- Pricing and billing metrics, including reserved instances pricing and spot pricing visibility

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	AWS: Summary View AWS service KPIs in a single dashboard		AWS: EC2 View detailed metrics from your EC2 instances. Check out new Dashboard features and framework through the link in the Overview section.	101	AWS: Billing View detailed billing metrics and potential cost saving opportunities		AWS: 53 view detailed metrics for your 53 services
	AWS: Pricing View the current prices for different EC2 instance types in each AWS region		AWS: ALB View detailed metrics for your Application Load Balancer services		AWS: API Gateway View detailed metrics for your API Gateway services		AWS: Auto Scaling View detailed metrics for your Auto Scaling groups
	AWS: CloudFront View detailed metrics for your CloudFront services in each AWS region		AWS: CloudSearch View detailed metrics for your CloudSearch services		AWS: CloudTrail View detailed metrics for your CloudTrail services		AWS: DMS View detailed metrics for your Database Migration services
	AWS: Direct Connect View detailed metrics for your Direct Connect services		AWS: DynamoDB View detailed metrics about your DynamoDB services		AWS: EBS View detailed metrics for your EBS services		AWS: EC2 Reservations View reserved EC2 instances by type
	AWS: ECS View detailed metrics from ECS services, task definitions, and containers	1100.11	AWS: ECS (Fargate) View detailed metrics from ECS (Fargate) services, task definitions, and containers		AWS: EFS View detailed metrics for your EFS services in each AWS region		AVVS: ELB View detailed metrics from your ELBs
	AWS: EMR View detailed metrics for your Elastic Map Reduce Services in each AWS region		AWS: Elastic Beanstalk View detailed metrics for your Elastic Beanstalk services		AWS: ElastiCache (MemCached) View detailed metrics from your ElastiCache (MemCached) cluster		AWS: Elasticsearch View detailed metrics for your Elasticsearch services
	AWS: Elastic Transcoder View detailed metrics for your Elastic Transcoder services	1.01-00	AWS: IOT Core View detailed metrics for your IoT Core services		AWS: IAM Access Key Age view detailed metrics for your IAM Access key age		AWS: Kinesis Data Stream View detailed metrics for your Kinesis Data Stream services
	AWS: Kinesis Firehose View detailed metrics for your Kinesis Firehose services		AWS: KMS View detailed metrics for your Key Management Services in each AWS region		AWS: Lambda View detailed metrics about your Lambda services		AWS: OpsWorks View detailed metrics for your OpsWorks services
	AWS: RDS View detailed metrics for your RDS services		AWS: Redshift View detailed metrics about your Redshift services		AWS: Route 53 View detailed metrics for your Route 53 services		AWS: SNS View detailed metrics for your SNS services
	AWS: SQS View detailed metrics for your Simple Queue Services in each AWS region						

Wavefront provides AWS observability with built-in monitoring for ~40 AWS services

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The Wavefront AWS integration ingests data from the following products:

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CloudWatch

retrieves AWS <u>metric</u> and dimension data.

CloudTrail

retrieves EC2 event information and creates Wavefront System events that represent the AWS events.

AWS Metrics+

retrieves additional metrics using AWS APIs other than CloudWatch. Data include EBS volume data and EC2 instance metadata like tags. You can investigate billing data and the number of reserved instances. Be sure to enable AWS+ metrics because it allows Wavefront to optimize its use of Cloudwatch and saves money on Cloudwatch calls as a result.

For more information on Wavefront AWS metrics collection, please see Wavefront AWS <u>documentation</u>. alse RROR_Y" = False -y = True = "MIRROR_Z" d.use_x = False d.use_y = False d.use_z = True

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Monitoring AWS Health

The <u>Wavefront AWS integration</u> provides packaged visibility into key AWS performance, health, and cost metrics. The pre-packaged visibility from these dashboards enables cloud monitoring teams to isolate potential resource bottlenecks quickly. The Wavefront AWS integration provides both ata-glance summarized views across the entire AWS footprint and detailed component views of individual AWS component consumption. Data can be grouped by different dimensions (tags), offering easy navigation to particular resource bottlenecks or anomalies. Using the power of the Wavefront Query Language, all packaged dashboards can be cloned and customized, and packaged data is correlated with top-level composite service performance, giving engineering teams the ability to tailor dashboards to their specific use cases.

Below are some of the packaged dashboards with corresponding AWS metrics provided by Wavefront AWS Monitoring Suite.



Granular EC2 Visibility

Wavefront AWS dashboards provide visibility into the performance of Amazon EC2 hosts including:

- Number of successful and failed instances
- Total number of running instances by region and type
- Overall CPU utilization
- CPU usage by region

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Real Time EKS Health Insights

Wavefront EKS dashboards provide real-time Kubernetes monitoring of key EKS metrics, including:

- Detailed health of your infrastructure and workloads.
- Metrics by namespace: Details of your pods/containers broken down by namespace.
- State of Kubernetes objects such as pods, services, deployments and daemon sets.



Continuous Lambda Monitoring

Wavefront AWS Lambda dashboards provide continuous visibility into Lambda metrics including:

- Lambda function invocations
- Lambda function errors
- Lambda function cold starts
- Execution time of the Lambda function handler (in milliseconds)

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Why Choose Wavefront for AWS Observability?



Real Time, Graphical Visualization of Your Global AWS Resources

Enhanced Wavefront AWS dashboards provide a rich graphical visualization of your AWS resources across the globe. With real-time, color-coded node-maps, SRE, and DevOps teams can easily view their AWS resources across different regions and quickly find nodes that exceed any metric threshold.



Analytics-Driven Insights into AWS - Performance and Utilization

Wavefront provides analytics-driven, pre-built dashboards to monitor key AWS services including EC2, EBS, EKS, Kinesis Firehose, CloudFront, CloudTrail, Lambda, ELB, DynamoDB, Redshift and many more. These insights equip you to make data-driven decisions for things like AWS capacity planning and resource optimization.

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Self-Service

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Built-In Visibility into AWS Billing Can Save You a Bundle

Wavefront applies analytics to your real-time AWS resource consumption with detailed AWS pricing, to show you how to reduce your cloud costs – many customers have used this to save over \$60K monthly!



Real-Time Full-Stack

Unified, Full-Stack AWS Monitoring That Reduces MTTR

Wavefront makes it easy to pull together metrics, traces, and histograms from applications, infrastructure, and different AWS services (including CloudWatch, CloudTrail, and other AWS APIs), providing a unified, full-stack view that significantly reduces MTTR.

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What Should You Monitor on Azure?

Azure is the second most popular public cloud provider after AWS and is quickly gaining market share. In this section, we will cover key Azure metrics to monitor, provide details on Wavefront Azure integrations and go over some cost benefits of monitoring Azure metrics in Wavefront.

Microsoft Azure Monitor provides base-level infrastructure metrics and granular performance and utilization metrics for most services in Azure (see the <u>documentation</u>. To get a full picture of the health of all services and corresponding resources, DevOps and SRE teams often categorize metrics into four categories, i.e., capacity, errors, latency, and throughput.

Below are some of the key Azure metrics to monitor for Azure.

Metrics	Azure Virtual Machines and Virtual Machine Scale Sets	Azure Storage Accounts	Azure Web Apps
Capacity	Percentage CPU, CPU Credits Remaining, CPU Credits Consumed, AutoscaleSettings ObservedMetricValue, AutoscaleSettings ObservedCapacity	UsedCapacity (StorageAccounts/Blobs/ Tables/Queues/Files)	UsedCapacity (StorageAccounts/Blobs/ Tables/Queues/Files)
Errors	N/A	Availability	Http 3xx errors, Http 4xx errors, Http 5xx errors
Latency	Disk Read/Write Bytes/Sec, Disk Read/Write Operations/Sec	Average SuccessE2ELatency, Average SuccessServerLatency	AverageResponseTime
Throughput	Network In/Network Out, Disk Read/Write Bytes/Sec, Disk Read/ Write Operations/Sec	Total Transactions, Total Ingress, Total Egress	AverageResponseTime

Key metrics to monitor for different Azure services

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Easily Monitor Azure Virtual Machines, Scale Sets, Storage Accounts and Container Instances with Wavefront

Whether you are using Azure virtual machines or have virtual machine scale sets configured to deploy, manage and auto-scale identical VMs for large-scale applications or have a containerized environment using Azure containers, in each case, you can easily monitor all your Azure resources using the Wavefront Azure Integrations.

All Wavefront integrations come with pre-built dashboards that show you a view of all your resources. You can filter information, change time windows, compare different points in time, and even clone the dashboard to add and remove more charts. The screenshot below shows the Wavefront dashboard for Azure Virtual Machine Scale Sets. In one glance, you can see:

Overview dashboard of Azure Scale Sets

across different subscriptions, regions and resource groups

Top 10 Stats

such as top 10 VMs by CPU utilization or network in/out for selected resource groups

Performance Metrics

such as CPU utilization, disk read and write bytes, IOPS, and network in and out throughput for selected scale set

Auto Scaling metrics

such as observed capacity, scale actions initiated and metric threshold vs. value

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Pre-built Wavefront dashboard for Azure Virtual Machine Scale Sets

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Similar dashboards are included for Azure Virtual Machine instances, Azure Storage Accounts and Azure Container instances as well. The following screenshot shows the dashboard for Azure Storage Accounts, which shows all active Azure storage accounts, and corresponding metrics such as account used capacity, total transactions, ingress, server latency and E2E latency.

Overview ~			2
ACTIVE RESOURCE G	ROUP(S)	ACTIVE STORAGE ACCO	DUNT(S)
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Pre-built Wavefront dashboard for Azure Storage Accounts

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Why Choose Wavefront for Azure Observability



Out-of-the-Box Visibility Into Azure

Wavefront provides out-of-the-box curated dashboards to monitor key Azure services and resources such as virtual machines, scale sets, storage accounts, container instances, and many more. DevOps and SRE teams can concentrate on services and resources they care about because they can easily filter based on parameters like subscription, region, and resource groups.



Behavior-Based Alerts Identify Anomalies in Your Azure Usage and Performance

With Wavefront, you can easily compare current Azure resource consumption and application performance with previous weeks and turn queries into intelligent, dynamic alerts that are triggered when Wavefront notices something abnormal in your Azure environment. Additionally, you can get alert notifications on the channel of your choice (Slack, PagerDuty, ServiceNow, HipChat, and so on).

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Unified, Full-Stack Azure Observability Can Significantly Reduce MTTR

Wavefront provides over 200 integrations, so you can easily unify metrics and alerts from different Azure services, applications, and infrastructure. A unified, full-stack metrics view becomes available to your SREs and DevOps teams, including developers–leading to a significant reduction in MTTR.

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What Should You Monitor on GCP?

GCP is a top three public-cloud computing provider along with AWS and Microsoft Azure. Like other cloud providers, GCP lets you spin up compute, storage, network resources on the fly. It offers a variety of services such as Google Cloud Functions, Google ML Engine, and Google Container Engine.

Stackdriver, the Google Cloud's embedded observability suite, is designed to monitor, troubleshoot, and improve cloud infrastructure, software, and application performance.

Google Stackdriver's main features include:

Stackdriver Monitoring

provides visibility into the health and performance of cloud services running on GCP and AWS. Stackdriver Monitoring is based on collectd, an open-source daemon that collects system and application performance metrics. Stackdriver Monitoring collects metrics, events, and metadata from various sources, including GCP, AWS, hosted uptime probes, and application instrumentation. All the ingested data can be visualized via dashboards, charts, and alerts.Stackdriver alerting is integrated with tools like Slack and PagerDuty, so your team can get alerted on the tool of their choice.

Stackdriver Trace

is a distributed tracing system for Google Cloud Platform. It collects latency data from your applications and generates in-depth latency reports which surface any performance degradations seen in your applications. Stackdriver Trace can capture traces from all your VMs, containers, or App Engine projects.

Stackdriver Logging

is a log-management service offered by GCP. It enables you to store, search, analyze, and alert on log data and events from GCP and AWS. It's a fully managed services that is built for scale and can handle system log data from thousands of workloads. Furthermore, it enables you to analyze all the log data in real-time.

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Achieve OOTB GCP Observability with Wavefront

In response to increasing demand from Wavefront customers, we have introduced Wavefront GCP Integration. The Wavefront GCP integration collects, analyzes, and visualizes key metrics from Google Compute Engine, Google Kubernetes Engine, and other Google Cloud <u>services</u>. It delivers metric-driven visibility into critical cloud performance and usage metrics. In addition, you can monitor all your applications that run on Google Cloud with Wavefront.

The GCP integration is full-featured native integration offering agentless data ingestion of GCP metric data, as well as pre-defined dashboards and alert conditions for certain GCP services



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Wavefront provides in-depth integrations and pre-built dashboards for 15+ GCP services, including the following:

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See <u>our documentation</u> for more details and the most up to date list of Wavefront GCP integrations.

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vavefront-gcp-dev v Zone * v Cluster *	v Pod * v		^
er			
This dashboard provides complete visibility into each level of a Google Container Engine	Container Engine (GKE) cluster including cluster, node, namespace, pod, pod container, and system cor	ntainer metrics. This is made possible through Wavefront's easy out-of-the-box integration w	Ith GKE. More information about GKE metrics can be found in the Container Engine metrics
40	54	454	89
Nodes	Namespaces	Pous	Containers
	8		
267.64	94%	15%	0.5%
Total Reserved Cores	P99 Container Memory Utilization	P99 Container CPU Usage	P99 Container Disk Capacity Utilization
pry / Uptime			
y			
d Zone: *			
zation of GKE Node (GCE Instance)	Network IO of GKE Node (GCE Instance)	Disk IO of GKE Node (GC	E Instance)
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Pre-built Wavefront GKE Dashboard Showing Nodes, Namespaces, Pods, Containers etc.

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Why Choose Wavefront for GCP Observability?





Out-of-the-Box, Real-Time Visibility Into Google Cloud

Wavefront provides turn-key visibility into GCP and resource metrics with pre-built dashboards. We monitor key GCP services and resources including Google Compute Engine, Google Container Engine, Pub/Sub, Spanner, Storage, Datastore and many more.

Behavior-Based Alerts Identify Anomalies in Your Google Cloud Usage or Performance

With a Wavefront, you can quickly compare your current GCP resource consumption and application performance behavior with previous weeks and turn that query into an intelligent, dynamic alert, that gets triggered when something abnormal happens in your GCP environment.

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Unified, Full-Stack GCP Monitoring That Can Significantly Reduce MTTR

Wavefront provides over 200 integrations, so you can easily unify metrics and alerts from different Google Cloud Platform services, applications and infrastructure – providing unified, full-stack metrics view to your DevOps teams including SREs and developers and leading to significant reduction in MTTR.

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5. How to Monitor VMware Cloud on AWS

VMware Cloud on AWS is an integrated cloud offering developed jointly by AWS and VMware. VMware Cloud on AWS enables you to extend your on-premises VMware vSphere-based environments to the AWS cloud while keeping a consistent operational model - retaining your familiar VMware tools, policies, and management as well as investments in third-party tools.

Powered by VMware Cloud Foundation, VMware Cloud on AWS integrates vSphere, vSAN and NSX, is supported by VMware vCenter management, and is optimized to run on dedicated, elastic, bare-metal AWS infrastructure. The applications running on VMware Cloud on AWS have access to a broad range of AWS services. IT teams can manage their cloud-based resources with familiar VMware tools. Customers leverage VMware Cloud on AWS for the following solutions, among others:

- Seamless cloud migration
- Flexibility of on-demand capacity
- Disaster recovery as a service with VMware Site Recovery

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VMware Cloud on AWS enables extending on-premises VMware vSphere-based environments to the AWS cloud

For details, see the VMware Cloud on AWS documentation.

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Easily Monitor VMware Cloud on AWS with Wavefront

The <u>Wavefront VMware Cloud on AWS integration</u> provides visibility into the health of your vSphere-based environment. The integration automatically pulls metrics from vSphere and populates the following dashboards with below-mentioned metrics:

Summary

shows a summarized view of all dashboards for vSphere environment

Cluster

shows an overview of cluster metrics including number hosts, VMs, memorystores in the cluster.

Datastore

provides detailed metrics about your datastore

ESXi Host Summary

provides summarized metrics for each ESXi Host for one or more clusters

ESXi Host Detail

provides detailed metrics for any ESXi Host

VM Summary

shows summarized metrics for each VM for any ESXi host

VM Detail

shows detailed metrics for any VM

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Wavefront ingests vSphere metrics using the vSphere input plugin for Telegraf. For details on the metrics and on how to configure ingestion, see the <u>vSphere plugin</u> details on GitHub.

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: Cluster Dashboard	: Host Summary / Host Detail	: VM Summary / VM Detail	: Datastore Dashboard
Cluster(s)	e 2 Host(s)	29 VM(s)	Datastore(s)
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VMware on AWS Wavefront integration vSphere Summary Dashboard showing clusters, hosts, VMs and datastores summary

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6. How to Enhance Amazon CloudWatch to get Unified, Full-Stack, Multi-Cloud Observability

Amazon CloudWatch is a component of AWS that provides detailed monitoring data, in near real time, for AWS resources and workloads running on AWS. CloudWatch is a good start for monitoring AWS services, but you're going to need a lot more to assure the quality of your cloud applications for your users. Gathered from our customers, here are the five top reasons for augmenting CloudWatch with Wavefront:

1. Expand Visibility to All Services of Your Full Stack, Beyond Just AWS

CloudWatch monitoring is restricted to metrics from AWS resources. That means CloudWatch doesn't aggregate or correlate metrics across different clouds. Wavefront correlates monitoring and analytics across multi-cloud environments, including all the top cloud providers, AWS, GCP and Microsoft Azure. Using <u>Wavefront's 200+</u> <u>built-in integrations</u>, you can easily visualize, analyze, and alert not only on metrics from multiple cloud services but from different workload environments such as Kubernetes, VMware Enterprise PKS, VMware vSphere, web apps, data stores and metrics from instrumented applications code.

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Wavefront Across Major Public Cloud Real-Time Visibility

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2. Combine the Global View Across Your AWS Environment Health with a Deep Dive Across Layers

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CloudWatch visualizes key single-instance, system-oriented metrics, but it alone can't show overall AWS environment health at different levels of aggregation. Overall, multi-level views enable quick identification of trouble spots. Wavefront added to CloudWatch reduces AWS incident resolution from hours to seconds using interlinked out-of-the-box dashboards for a comprehensive multilevel view of your complete cloud infrastructure. Wavefront's globe chart best illustrates your AWS infrastructure health across regions worldwide, and Wavefront's node map chart shows you regionspecific metrics of your EC2 instances. You can drill down to a troubled instance quickly and identify the root cause at a glance.

> Wavefront Interlinked Multi-View of AWS Infrastructure



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3. Troubleshoot Microservices Faster with Metrics, Histograms, Traces and Span Logs

For troubleshooting applications that use AWS ECS or AWS Lambda, CloudWatch/CloudTrail offers only a few metrics and some complex logs. Consider using Wavefront's enterprise observability instead. We offer the unique monitoring combination of out-of-the-box metrics, histograms, and traces at cloud scale, with potentially over a million data points per second. Metrics tell you system-wide when there is a problem. Histograms can overcome the limitations of averages. Histograms help you find problems with high-speed metrics like sub-second response times and latencies. Distributed tracing, with visibility into the entire API call flow, lets you drill down and isolate issues across? In? microservices. In short, Wavefront is a single platform that unifies metrics, histograms, and traces and significantly reduces MTTR.



Wavefront Enterprise Observability – Metrics, Histograms, Traces – Go System Wide to Detailed Flow for Faster Troubleshooting

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4. Enrich Your AnalyticsFunctionality and EmpowerNovice Users

CloudWatch offers less than 20 elementary math functions that you can use to query CloudWatch metrics and to create new times series based on these metrics. Using Wavefront, you can take advantage of 120+ analytic functions, from aggregation and raw aggregation, filtering and comparison, standard time and moving window time, conditional, rounding, missing data, metadata, exponential and trigonometric, predictive and histogram, event and miscellaneous functions.

Furthermore for users who want to experience the full Wavefront power but don't have the time to build their own analytics models, Wavefront offers AI/ML assistance through <u>AI Genie</u>. AI Genie uses patent-pending AI/ML technologies to automate anomaly detection and forecasting for any time series metrics, for AWS resources and the application workloads that run on AWS infrastructures.



Wavefront AI Genie Automated Real-Time Anomaly Detection on Streaming Metrics

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5. Smarten Your Alerts and Get Notified on Real Issues, not False Alarms

With CloudWatch, you're limited to predefined basic alarms created using limited rules and math functions. Alert notifications , as well as the automated actions you're able to take, are also limited. With Wavefront Alerting there are no limits. You can fine-tune your alarms using the industry's most advanced query language and analytics engine, using a single function or a combination of any of 120+ analytics functions on one or multiple time series metrics. Alert notification targets include email, PagerDuty, OpsGenie, Slack, and more. You can even use Al Genie to find an anomaly or predict bottlenecks, then create an intelligent alert for critical incidents directly from Al Genie.

See the table on the right for a summary of what Wavefront offers on top of Cloudwatch. $\bullet \bullet \bullet \bullet \bullet \bullet$

Metrics	Cloudwatch	Wavefront
AI/ML	NA	Holt-Winters, AI Genie (AI/ML-based anomaly detection and forecasting)
Alerting	Basic No behavior-based smart alerts	Behavior-based smart alerts Al Genie anomaly-based alerts
Analytics	13 basic math functions	120+ functions
Datacenter Type	AWS, On-premises	Multi-cloud (AWS, Azure, GCP), on-premises
Granularity / Latency	Basic: 5 min Detailed: 1 min High resolution: 10 sec, 30 sec, x60 sec Custom: up to 1 sec	All: 1 sec (real-time)
Integrations	Only AWS Services (70+)	190+
OS Monitoring	Linux, Windows	Linux, Windows, Mac
OS Monitoring	Complex	1 pps/month
Retention and Aggregation	15 months retention Aggressively rolls up: <60 sec for 3 hours 1 min for 15 days 5 min for 63 days 1 hour for 15 months	18 months retention No rolloups

Ways that Wavefront Expands on CloudWatch

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7. How to Monitor Serverless Applications in AWS

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AWS Lambda, introduced by Amazon in 2014, was the first public cloud vendor offering of a functions-based, serverless computing service. AWS Lambda empowers developers by letting them run code in production without provisioning or managing servers. You pay only for the compute time you consume; there is no charge when your code is not running.

As a developer, if you're using AWS Lambda, in addition to writing AWS Lambda functions, you also need to think about your monitoring strategy for your functions running on AWS Lambda. After all, a function is nothing but the code written by the developer and with AWS Lamgda, it runs on the AWS infrastructure automatically. But just like any other piece of code, it's the responsibility of that developer to monitor those functions for performance and reliability.

AWS Lambda and Amazon CloudWatch

AWS Lambda performs some automatic monitoring of Lambda functions on your behalf, and reports those metrics metrics through Amazon CloudWatch. To help you monitor your code as it executes, Lambda can automatically track:

- Number of requests
- Latency per request
- Number of requests resulting in an error

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AWS Lambda publishes these metrics to Amazon CloudWatch. Using the Wavefront Amazon CloudWatch integration, you can retrieve all those metrics from? in? Wavefront. Once the integration is set up and metrics are flowing to Wavefront, you can run analytics to create charts, dashboards, and alerts. But the question you might ask is: "Why pay Amazon to store and export metrics from CloudWatch?", and as well, "Why add a visualization lag by extending your metric pipeline using CloudWatch?" Instead of setting up the CloudWatch integration and exporting AWS Lambda metrics from CloudWatch to Wavefront, what if your functions can send the metrics directly to Wavefront with minimal network overhead, very little additional code, and lower overall cost

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How to Monitor Serverless Better with Wavefront

Using the Wavefront Lambda SDK (Python, Go, Node.js), you get all the standard Lambda metrics out-of-the-box sent directly from your Lambda functions to the Wavefront service. As an application developer, you only need to focus on writing your Lambda function and to copy/ pasete a little little additional code to monitor those functions in Wavefront. There is no need to invest time and money to set up Wavefront's AWS CloudWatch integration in order to monitor your Lambda function. There is no need to pay AWS CloudWatch for storing and exporting those metrics to Wavefront. Also, since the metrics are coming directly from your Lambda function, they become available on Wavefront in real time - in contrast, when polling CloudWatch, you might get them every 5 minutes or so.

	Metric Name	Description
1	aws.lambda.wf.invocations.count	Count of number of Lambda function invocations aggregated at the server.
2	aws.lambda.wf.invocation_event.count	Count of number of Lamba function invocations.
3	aws.lambda.wf.errors.count	Count of number of errors aggregated at the server.
4	aws.lambda.wf.error_event.count	Count of number of errors.
5	aws.lambda.wf.coldstarts.count	Count of number of cold starts aggregated at the server.
6	aws.lamba.wf.coldstart_event.count	Count of number of cold starts.
7	aws.lambda.wf.duration.value	Execution time of the Lambda handler function in milliseconds.

To make analysis even easier, the Wavefront Lambda SDK also adds following point tags to all the metrics.

	Point Tag	Description
1	LambdaArn	ARN (Amazon Resource Name) of the Lambda function.
2	Region	AWS Region of the Lambda function.
3	accountId	AWS Account ID from which the Lambda function was invoked.
4	ExecutedVersion	The version of Lambda function.
5	FunctionName	The name of Lambda function.
6	Resource	The name and version/alias of Lambda function. (Ex: DemoLambdaFunc:aliasProd).
7	EventSourceMappings	AWS Event source mapping Id (Set in case of Lambda invocation by AWS Poll-Based Services).

Along with the standard metrics, it is also possible to send custom business metrics directly from your Lambda function to Wavefront. Refer to <u>this blog</u>, to learn more about sending custom metrics from Lambda functions to Wavefront.

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Lambda Integration Sample Code

As an application developer if you're developing your Lambda function in say Python, all you have to do is to decorate your AWS Lambda handler function with @wavefront_lambda.wrapper, and voila, all the standard Lambda metrics with the point tags are sent directly to Wavefront.

import wavefront_lambda

@wavefront_lambda.wrapper
def handler(event, context):
 # your code

We've included an integration tile in Wavefront to give you easy access to out-of-the-box Wavefront AWS Lambda dashboards. Here are a couple of example dashboards:



Wavefront AWS Lambda Dashboards

Note: You can also monitor custom metrics that are sent directly to Wavefront using these dashboards.

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8. AWS App Mesh Observability and Analytics

AWS App Mesh is a service mesh based on the <u>Envoy</u> proxy that makes it easy to monitor and control containerized microservices.

Critical KPIs to Monitor in AWS App Mesh

In any service mesh, including AWS App Mesh, critical KPIs to monitor are as follows:

- Health of the service mesh
- · Health of your services
- Performance and activity of your services

Because App Mesh uses Envoy proxy as the data plane, you can determine the health of the mesh from Envoy proxy health stats. Envoy proxy also provides many health and activity metrics for different service clusters. Here are the metrics for the main components to monitor in a mesh.

Because App Mesh uses Envoy proxy as the data plane, you can determine the health of the mesh from Envoy proxy health stats. Envoy proxy also provides many health and activity metrics for different service clusters. Here are the metrics for the main components to monitor in a mesh.



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AWS App Mesh Observability with Wavefront

Wavefront collects health and performance metrics for App Mesh and its services via the Envoy proxy. Over 600 App Mesh/Envoy health and performance metrics are collected OOTB by the Wavefront integration. Additionally, Wavefront provides pre-built dashboards for App Mesh, enabling SREs and developers to quickly visualize, monitor, and troubleshoot any issues.

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This dapboard provides real-time visibility into AWS Age Mesh. Ago Mesh uses the open-source Envoy proxy, and adds realisence and observability to your services. Use the pull-down menu above to select the Source and Duster. You can find information above the metrics in the documentation documentation.					
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The overall health of App Mesh clusters shown in Wavefront



App Mesh service performance metrics shown in Wavefront

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Identify Sources of Latency with App Mesh Distributed Tracing in Wavefront

Distributed tracing allows developers and SREs to obtain visualizations of call flows in large microservices-based distributed systems. It can be invaluable in understanding serialization, parallelism, and sources of latency enabling developers and SREs to identify services that need optimization. Envoy reports tracing information for communications between services in the mesh. However, to be able to correlate the different pieces of the traces generated by different Envoy proxies, and to get a complete call flow across different proxies, the application needs to propagate



App Mesh distributed tracing view in Wavefront

the trace context. Wavefront, with its <u>Zipkin integration</u>, ingests distributed traces information from Envoy proxies and provides distributed traces visualization for App Mesh.

AWS App Mesh standardizes how your microservices communicate, helping you ensure high availability for your applications running in AWS. Wavefront provides built-in integrations for multiple AWS services including AWS App Mesh. With Wavefront's App Mesh integration, you get outof-the-box visibility into App Mesh metrics and distributed traces, making it easy to debug and identify the cause of any communication issues between your App Mesh services. Furthermore, with Wavefront, you can easily monitor, correlate and analyze the performance of different AWS services, applications, and infrastructure components.

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9. Optimize Both ServicePerformance and Cloud Costswith CloudHealth and Wavefront

As enterprises are adopting more public cloud services, they are often surprised by growing, instead of shrinking expenses. As a result, insight into cloud cost ROI is essential to make proper business decisions. CloudHealth by VMware helps you manage costs, usage, security, and governance across your entire cloud environment. CloudHealth analyzes native metrics from cloud providers out-of-the-box, but in many cases, that is not enough for a 360 view. If you use CloudHealth and Wavefront together, CloudHealth can take advantage of Wavefront's vast real-time, highly granular, multi-cloud (AWS, Azure, GCP) infrastructure usage metrics, and provide effective recommendations for cost savings of your service. By using CloudHealth and Wavefront together, you gain:

1) Rightsizing Analysis

In many large cloud environments, it's common to find severely underutilized infrastructure that drives up costs. Using CloudHealth In many large cloud environments, it's common to find severely underutilized infrastructure that drives up costs. Using CloudHealth and Wavefront together can help solve this problem. The Wavefront platform collects granular performance data from the application, CPU, memory, network, and disk usage from instances and virtual machines on AWS, Azure, and GCP. This tag enriched data is then ingested and used by CloudHealth

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you do rightsizing analysis by function, so you can quickly find which departments or teams need to adjust their behavior when provisioning new infrastructure.

3 - Balance Cost with Performance

Not only can CloudHealth help identify assets that are underutilized and that can be downsized for cost savings, but it can also help with tracking and managing expenses in the cloud. You can allocate and amortize costs and can forecast spend across departments and teams. Data and analysis from CloudHealth can be extended further into the Wavefront platform and correlated with application and infrastructure performance. Thus, DevOps teams can optimize cloud service performance and set real-time, proactive alerts for configuration changes and cost overruns.

Together, CloudHealth and Wavefront, enable you to easily improve efficiency and reduce cost without sacrificing productivity or performance.

to do a rightsizing analysis. CloudHealth provides specific recommendations around downsizing, or even terminating instances, including the suggested instance type for your services' optimal performance. By following these rightsizing recommendations, for example, downsizing an instance that is underutilized, you can save time and money without interruption to the service.

"I can easily identify which Elastic Load Balancers in a business unit do not have an AWS EC2 instance attached. This is just money on the table that we can easily save using Wavefront."

- Dieter Matzion, Staff Business Systems Analyst, Intuit

2 - Visualization of Key Assets Through a Business Lens

Together, CloudHealth and Wavefront give you real-time visibility into the performance of your service and enable you to zero in on the cloud data you care about by department, application, line of business, or any logical business grouping. This visibility also helps

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How Intuit Saved Millions Using CloudHealth and Wavefront

After evaluating multiple vendors for their cloud adoption transformation, <u>Intuit chose CloudHealth</u> for true cloud cost management and Wavefront for real-time performance monitoring, based on advanced streaming analytics.

Intuit integrates Wavefront and CloudHealth through the CloudHealth API, feeding Wavefront's tag-enriched resource usage data into CloudHealth's cloud cost-savings recommendations, saving millions of cloud cost dollars annually. Using rightsizing analysis, Intuit was able to move over half of its workloads to run smaller EC2 instances, saving them over \$100,000 a year. "CloudHealth feeds data into Wavefront in an aggregated fashion that is extremely powerful."

- Dieter Matzion, Intuit Cloud Architect

Intuit also forwards aggregated CloudHealth cost metrics to Wavefront for correlated monitoring and analytics-driven alerting. Specifically, <u>Intuit</u> <u>uses the Wavefront</u> powerful alerting engine to alert on cloud budget overruns.

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Intuit Saves Millions Using CloudHealth and Wavefront

\$6 billion Revenue Company

• 50 million people using TurboTax, QuickBooks and Mint

Challenges

- Manual, labor intensive and error-prone cloud management process
- Need to automate and optimize cloud spend

Why CloudHealth and Wavefront?

- CloudHealth for true cloud cost management
- Wavefront for real-time performance monitoring and analytics-driven alerting



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10. Top 5 Lessons Learned from Customers with Multi-Cloud Monitoring

1 - Choose an observability solution that is builtfor cloud and modern technologies

Over a period of time, we have seen our customers modernize their services and adopt emerging technologies. For instance, our customer <u>8×8's cloud service has evolved</u> <u>dramatically from being a monolithic piece of</u> <u>software. In line with industry trends and best</u> <u>practices, 8x8 moved to a services model,</u> <u>and, ultimately, to microservices</u>. We have also seen many customers embark on the journey of containerization and adopt different flavors of Kubernetes, including Amazon EKS andOpenShift. Common feedback from such customers was that it helped them to use an observability solution (like Wavefront), which has support for emerging technologies, including multi-cloud and Kubernetes. With Wavefront, customers don't have to worry about building observability support for emerging technologies. Traditional monitoring and APM solutions, on the other hand, often lack multi-cloud and emerging technologies support.



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2 - Siloed tools increase MTTR and slow down productivity

Before using Wavefront, many of our customers had one common problem. They were using many siloed monitoring solutions and didn't have a unified/first pane-of-glass view across different clouds, full-stack, and tools. This **lack of the first pane-of-glass view led to long MTTR and missed SLAs.**

Let me walk you through an example of one of our customers, one of the biggest Indian e-ticketing platforms. They mentioned that their SRE and DevOps team was using over half a dozen siloed monitoring solutions. Because they had so many tools, not many people knew how to use every tool. ("You just cannot expect them to learn every tool when you have over half a dozen monitoring tools," they said.) Furthermore, none of the teams had a unified view across all the tools. So, whenever an incident happened, they would have to look through several tools to troubleshoot a problem. This led to increased MTTR and missed SLAs. Additionally, when an incident happened, it resulted in several alerts from different tools leading to alert storms. Very often, an important alert was missed in this array of false positives leading to increased chances of missing SLAs.

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3 - Maintain sanity in cloud and save millions by controlling cloud cost and by proactively alerting on budget overruns

Many enterprises adopt a multi-cloud strategy to reduce costs. But they are often surprised to see their cloud cost go up due to different cloud's pricing models, varied types of instances, and underutilized workloads. **If you are using multicloud, it is essential to select rightsized instances and avoid budget overruns with proactive alerting.**

Wavefront customers have saved millions of dollars by using rightsized reserved instances recommended by the CloudHealth and Wavefront integration. Intuit, one well-known Wavefront customer, uses CloudHealth as a caching engine that retrieves and stores telemetry information from AWS. With the Wavefront CloudHealth integration, they feed this telemetry information into Wavefront and use Wavefront to monitor and alert on budget overruns.

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4 - Open-source monitoring solutions don't support cloud-scale and reliability

Many enterprises move to the cloud to take advantage of the the ability to scale up at a moment's notice. Reliability is one of the reasons for adopting multi-cloud. But while adopting multi-cloud for all these benefits, **enterprises often forget that their open source monitoring solutions lack support for scale and reliability.** For instance, consider this scale-limiting usecase of the open-source monitoring solution Prometheus. As a customer's footprint grows in the cloud, so do their metrics volumes as engineers add more and more necessary telemetry. But when one Prometheus node gets too busy with the increased number of metrics, it either needs to be hosted on a bigger instance with more horsepower, or you need to spin up another Prometheus instance. Both of the tasks need engineering team effort and cycles, leading to teams getting slowed down with scale. **Soon engineering teams find they're spending more and more time on scaling, patching, and maintain their open-source monitoring solutions and not having that time to focus on innovating and scaling their business.** Reliability is another big concern with open-source solutions. In fact, one of the biggest reasons for Boxever to switch from Prometheus to Wavefront was that Prometheus lacked support for a real high availability configuration.

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5 - To achieve exceptional SLAs, empower development teams with the ability to monitor their SLOs

As enterprises adopt a distributed microservicesbased architecture, the overall customer experience depends on performance and availability of many different microservices. These microservices are often owned by different development teams. <u>As mentioned by Edgar</u> <u>Nidome</u>, **Principal Architect at 8x8, it is critical to empower all development teams to take ownership of their metrics and performance.** Every development team should be able to measure and share the quality of service that they provide with other teams. But often, engineering teams find it hard to standardize how to share metrics and analytics information with different teams. Wavefront offers teams a centralized observability solution that different teams can easily share. With Wavefront, engineering teams can easily monitor their SLOs, taking complete responsibility for the performance and reliability of their services. **In short, make sure to give development teams the ability to have lightweight instrumentation, unify objectives and empower them to get to addressing their SLAs.**

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11. Why Customers Choose Wavefront for Multi-Cloud Observability and Analytics

Wavefront delivers turn-key observability across AWS, Azure, and GCP. Well-known enterprises such as Intuit and Workday and successful cloud-native companies like 8x8 and Reddit use Wavefront for monitoring their applications and infrastructure across different public clouds.

"Wavefront provides unparalleled visibility across all our cloud microservices helping hundreds of developers become more productive focusing on innovation, while enabling 8x8 to deliver exceptional SLAs and eliminate issues with our cloud services."

- Dejan Deklich, Chief Product Officer, 8x8

Here are the top three reasons why customers adopt Wavefront for Multi-Cloud Observability and Analytics

Real-Time Observability and Analytics Across All Major Public Cloud Platforms

With Wavefront, you get out-of-the-box, realtime observability across all major public cloud platforms – AWS, Azure, and GCP – with many public cloud integrations and pre-packaged dashboards showing key metrics for all major cloud services. You don't have to use different siloed products for different cloud providers. Monitoring multiple cloud services and platforms in a single solution has never been so easy!

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Real-Time Observability Across AWS, Azure, and GCP provided by Wavefront

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2 - Unified, Full-Stack Observability that can Significantly Reduce MTTR

Wavefront provides over 200 integrations. You can easily unify metrics, traces, and histograms from different AWS, Azure, and GCP services, applications, and infrastructure. The result gives a unified, full-stack view to your DevOps teams including SREs and developers and leads to a significant reduction in MTTR.



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3 - Optimized ServicePerformance and CloudCost with Wavefront andCloudHealth

With Wavefront, you can easily monitor cloud consumption and cost metrics and convert them into data-driven insights and alerts for reducing your cloud cost. Furthermore, by using CloudHealth and Wavefront together, you get effective recommendations for cost savings of your service that use CloudHealth's cost governance platform and Wavefront's vast real-time, highly granular, multi-cloud (AWS, Azure, GCP) infrastructure usage metrics.



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Author



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